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DISEASES OF THE NERVOUS SYSTEM

A PRACTICAL JOURNAL ON PSYCHIATRY AND NEUROLOGY

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DISEASES of the NERVOUS SYSTEM

A PRACTICAL JOURNAL ON PSYCHIATRY AND NEUROLOGY

Clinical Correlates of Exceedingly Fast Activity In the Electroencephalogram

E. L. GIBBS, F. M. LORIMER, M.D., and F. A. GIBBS, M. D.
Chicago, Illinois

In the course of routine electroencephalographic examinations patients have been encountered who showed an unusual amount of 30-40 per second activity in the frontal and central areas. Such activity may appear while the patient is awake (Fig. 1), but it is increased by drowsiness (Fig. 2), and in some cases appears only during drowsiness. With proper recording it can be distinguished from muscle by its sinusoidal form and relatively constant frequency.

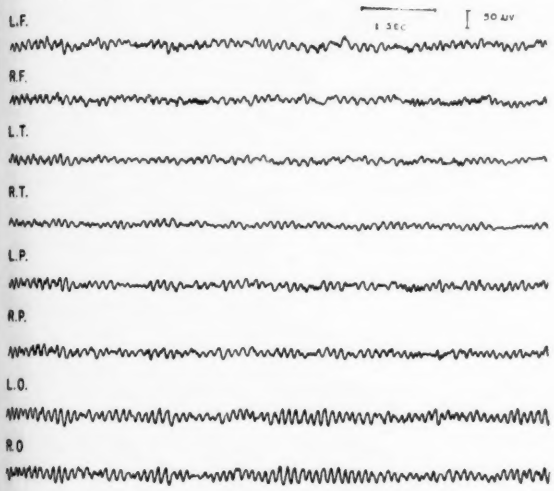

Fig. 1. Exeedingly fast activity, i.e., 30-40 per second with a voltage above 15 microvolts (F-3) in the frontal and parietal areas. Recorded during the waking state.

From the Electroencephalographic Laboratory, Hines General Hospital, Hines, Illinois, and the University of Illinois College of Medicine, Department of Psychiatry, Illinois Neuropsychiatric Institute, Chicago, Illinois.

Among 300 control subjects on whom electroencephalograms have been recorded during sleep, this rare type of fast activity has never been observed. In a few instances it has been encountered in patients with seizure discharges of the psychomotor, grand mal or petit mal type, but in such cases it appears to be entirely independent of the seizure discharges.

For the past year patients have been examined, their clinical charts abstracted, and the significant findings tabulated in an effort to find the clinical correlates, if any, of this exceedingly fast activity. Clinical data

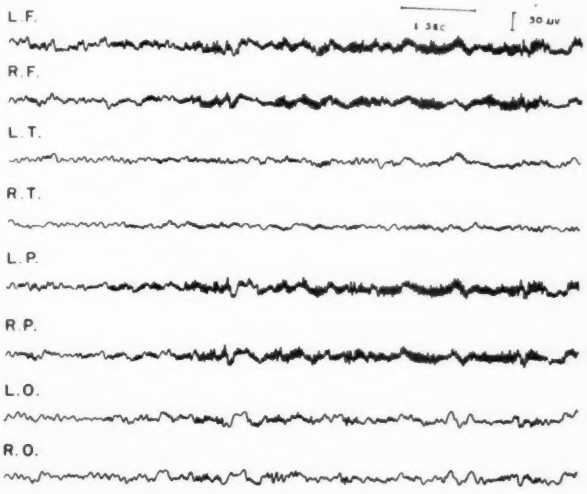

Fig. 2. Increase during drowsiness of exceedingly abnormal-fast activity, i.e., 30-40 per second with a voltage above 15 microvolts (F-3), in the frontal and parietal areas. This recording is from the same patient shown in Figure 1.

have been collected on a total of 68 cases with this type of abnormality. In 48 of these we relied almost exclusively on material presented in the clinical chart; in some of the cases the information was scanty, while in others it was adequate. However, 20 of the 68 patients were submitted to complete and entirely adequate clinical investigation. As will be seen (Table I), the correlating factors are the same in the two groops, the chief difference being a higher correlation in the completely studied group.

The most common symptoms encountered in patients with exceedingly fast activity were: headaches, "spells," restlessness, personality change, paresthesias, and vertigo. The incidence of each of these in the adequately and inadequately studied groups is shown in Table I. Of the less common symptoms were insomnia, amnesia, hallucinations, and weakness.

The headaches of which these patients complained were most usually described as intense, pounding, and more often localized than generalized. The most frequent site of localization was in one temporal area. The parietal and frontal areas were often involved, but maximal pain at the occiput or vertex was rarely reported. Although these headaches were associated with visual disturbances, such as flashes of light in some cases, they were not decribed as scintillating scotomas or fortification figures. There were no prodromal symptoms of the type common in migraine and neither nausea nor vomiting were associated with the headache. In the varied clinical impressions offered by consultant neurologists and psychiatrists, migraine was never proposed as a diagnostic possibility. It is worthy of note that electroencephalograms of patients with migraine do not show this exceedingly fast activity.

TABLE I

Symptoms Most Commonly Encountered in patients with Exceedingly Abnormal-Fast Activity in Their Electroencephalograms.

(30-40 per second waves with a voltage above 15 microvolts)

Symptom	*Percent with Specified Symptom*	
	Group with incomplete clinical data (48 cases)	Group with complete clinical data (20 cases)
Headaches	50	85
"Spells"	56	75
Restlessness	17	70
Personality Change	12.5	65
Paresthesias	21	55
Vertigo	27	55

The "spells" as reported by the patient or a relative were usually described as a faint or a "pass out," and when observed by a trained clinical observer, these terms were commonly used: "bizarre," "atypical epileptic attack," "not a convulsion." The unconsciousness was usually associated with flaccidity. Only very rarely were there tonic or clonic movements, tongue biting, salivation, or loss of sphincter control. Very brief lapses of consciousness with rhythmic blinking of the eyelids such as might be classified as petit mal were not reported. At times the spells were unassociated with loss of consciousness or collapse. Instead, there was an indefinite period of hours, days or weeks during which the patient was confused and amnesic, or was unable to concentrate. One patient, a carpenter by trade, described periods in which "everything seemed far off," and all his actions required the utmost effort of concentration. He gave as an example of tasks that had been difficult the almost automatic performance for a carpenter of driving a nail. Most of the patients seemed to be aware of their "spells" but were unable or unwilling to alter them. In many of the cases the behavior of the patient was considered hysterical and a careful search for emotional, inciting events was attempted by the psychiatrists who saw these patients. In only one case, however, was such a definite relationship found. In most of the cases the psychiatrists expressed doubt of the emotional nature of the condition and referred the patient to a neurologist.

In some cases the patient was seen by more than one neurologist or at successive intervals by the same neurologist, and two patients were presented before neurological conferences. The majority of patients had skull x-ray and spinal fluid examinations; a few had pneumoencephalograms. In all cases except one the neurological, serological and spinal fluid examinations were noncontributory. In this one case there was a

Brown-Sequard syndrome due to fracture of the cervical vertebrae following a dive into a shallow pool.

In some instances the behavior during the spell was characterized as anti-social, as for example, wandering, extreme irresponsibility, and at times assaultiveness. In 70 per cent of the cases which were given adequate clinical study, restlessness was reported as a significant finding. This usually consisted of poorly organized, purposeless, agitated, indifferent behavior. In most cases such behavior was continuous and considered to be separate and distinct from the "spells." There seemed to be a decided difference between the behavior of these patients and those commonly classified as "psychopaths." The latter are usually characterized by distorted motives and desires, and show a type of behavior which is abnormally motivated, but in terms of this motivation is more or less reasonable and at times even clever. The behavior of the present group of patients was, by any standard, stupid, senseless, and impulsive, without evidence of motivation by ideas of either gain or self-punishment. Impairment of judgment was usually an outstanding feature of the psychiatric evaluation. In the 60 per cent of patients with personality changes the changes were always for the worse. An attempt to correlate the personality features with existing psychiatric classifications was not fruitful. The group do not seem to yield themselves to classification in terms of present psychiatric nosology. The personality change most closely corresponds to that which at times follows encephalitis. Apathy, indifference, lack of judgment, antisocial behavior with and without alcoholism, poor work record, domestic discord, and asocial behavior with vagrancy, and general social inadequacy were outstanding features of these cases. Impairment of comprehension and of the capacity for elaborating impressions, and also for the recall and utilization of memories were usual. Four of the patients were considered psychotic; three of these were classified as "simple schizophrenics." "Psychopathic state" was the term most frequently used by consultants in diagnosis.

Paresthesias which were reported by half of the adequately studied group consisted of such vague somatic sensations as "pins and needles," numbness, tingling, itching in the external ear, behind the ear, and in the nose. Pains in the chest, arms and legs were also described. Complaint of visceral disturbances were rare. These paresthesias usually developed maximal intensity during the "spell," and were only very rarely a warning or aura of the "spell." Complaints of vertigo were so definite in four cases that they were referred to otologists, and in each case the vertigo was classified as of central origin.

A search for possible etiological factors revealed nothing significant. As might be expected, head injury was the most frequently mentioned cause. However, only 55 per cent of the patients gave a history of head trauma, and in the majority of the cases this was of a mild type without fracture, neurological signs or prolonged unconsciousness. The severity of the head injury seemed to bear no relationship to the severity of the degree of E.E.G. abnormality.

The following case history is cited as typical of the group: C.Y., a 34-year old white male had four admissions to the hospital over a period of two years. During each examination primary attention was directed toward an understanding of his personality and toward a detection of the cause of the exceedingly fast activity which appeared in his electroencephalogram. At each examination the patient's chief complaints were as follows:

1. Intermittent headache.
2. Nervousness and irritability.
3. Blackout spells.
4. Slight memory impairment.
5. A numb feeling in his hands and legs.

The patient enjoyed good health until 1942 when he received an injury in combat. He sustained body wounds but there was no history of direct injury to his head. Later, the same year, however, he sustained a minor blow to his head but did not lose consciousness. About six weeks thereafter the patient began to suffer from "bursting, throbbing" headaches, generally localized to the right temporal area but spreading to the ipsilateral parietal and frontal regions. Aspirin, codeine and gynergen were tried by various doctors, but gave little relief. The

headache first occurred at 30 to 60 day intervals, but later came every two weeks. The nervousness and irritability were characterized by the examining psychiatrist as explosive, unpredictable and uncontrollable, and apparently unprecipitated by emotional stimuli or special situations. A neurologist observed one of the "spells" and reported that the patient complained severely of headache. He thrashed about in bed with a flushed face and constricted pupils, but was conscious. There was some question as to whether or not he was confused. There were no significant neurological findings. The patient never convulsed, bit his tongue nor became incontinent.

In the past six years the patient's personality has undergone progressive deterioration. He has gradually become unable to hold a job, drinks heavily, and makes impractical and unrealistic plans for marriage. He reacts with irritability and with impulsive, antagonistic behavior to people who try to help him. Reliable information regarding his previous personality indicates that before the development of the present symptomatology the patient's judgment was normal and he had made a fair social adjustment. He is now dependent upon hospitalization for his maintenance.

Repeated physical and neurological examinations have been entirely negative. Skull x-rays have been consistently reported as "no evidence of abnormality." Complete blood counts, urinalysis, serology, blood glucose, glucose tolerance tests, blood proteins, phosphorus, alkaline phosphatase, cephalin flocculation have been within normal limits. Examination of the spinal fluid has revealed no abnormalities. Psychological tests were reported as showing "some characteristics of organicity." Seven electroencephalographic tracings have shown consistently bursts of 30 to 40 per second activity with a voltage of 15-20 microvolts in the right frontal and parietal areas. The patient has been tried on Dilantin and phenobarbital, and blood bromide levels of between 200 and 300 mgm/100 cc. have been maintained for long periods. On no medication has there been significant improvement.

The diagnosis of the consulting psychiatrist was as follows: "Somatization reaction and anxiety reaction manifested by dizzy spells, so-called blackout spells and increasing irritability and cephalgia, cause undetermined." The neurological consultant made this comment: "Although there is an obvious background of emotional instability, I believe these peculiar *blackout* episodes have not been fully explained so far and that further studies are necessary to rule out some organic pathology."

Summary and Conclusions

Bursts or runs of 30-40 per second activity with a voltage of more than 15 microvolts are not encountered in the electroencephalograms of normal control subjects. A study of 68 patients with this type of electroencephalographic disorder reveals that it is most likely to appear during drowsiness and very light sleep. The most common symptoms of patients with such disorder are: headaches, "blackout" spells, restlessness, personality changes, paresthesias, and vertigo. These patients do not fit into any recognized clinical diagnostic group, but they usually fit the characterization "dull psychopath." No common etiological factor could be found, but by analogy with other types of cerebral dysrhythmia it is believed that exceedingly fast activity is an irritative reaction to an intermediate degree of brain injury of a non-specific type.

Authors' Note: The foregoing article is published with permission of the Chief Medical Director, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or conclusions drawn by the authors.

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Lobotomy in the Management of Intractable Pain and Narcotic Addiction

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The purpose of this paper is to present the results in a series of 20 patients suffering from intractable pain who were treated by prefrontal lobotomy. We make no pretension to having added any new procedure or technique. It seemed worthwhile, however, to report our experiences with a fairly representative series of cases, particularly since there has been increasing interest in the application of prefrontal lobotomy for intractable pain.[1,2]

Pain is the symptom which most frequently attracts the physician's attention. Eradication of the underlying cause in most instances effects a cure and pain ceases to be a problem. Pain, which persists, often can be treated either with analgesic or anesthetic drugs or the patient adjusts to his state. In particular, there is the persistent intractable pain which is most frequently associated with carcinomatosis. Various neurosurgical techniques have afforded to a large percentage of patients suffering from such pain, a considerable amount of relief.[3,4] Among these procedures are posterior rhizotomy, cordotomy, spino-thalamic tractotomy, mesencephalic tractotomy, cortical excision, and sympathectomy. Anesthetic agents locally or systemically, psychotherapy and hypnosis have also been useful.

However, the problem of intractable pain presents another complex phase. This is the presence of the human emotional factor. Physical pain then merges with or is complicated by mental pain. Situations such as this occur. A fastidious woman, in the prime of life, develops either a carcinoma of the rectum, followed by colostomy; or carcinoma of the cervix, upon which is superimposed a vesico-vaginal or recto-vaginal fistula. The shock of this situation is enough to shake even the most stoic of personalities. Superimpose upon this either the explicit or implicit knowledge, by the patient, of the presence of cancer. Complicate this situation with a sense of progressive deterioration of well being, as the disease process advances and add to this a gradually developing narcotic addiction and a patient complex develops which taxes the ingenuity of all in attendance. It is in this type of patient, and in this sphere in which the mental state can be modified, that prefrontal lobotomy may serve as a most useful method.

In 1943, Freeman and Watts reported a series of patients who, while suffering from intractable somatic pain, had a preponderently emotional problem for which prefrontal lobotomy was executed.[4,5] The striking improvement in the palliation of pain suggested the extension of the procedure to patients suffering from somatic pain in which the psychotic element was minimal.[6,7] Since then, several reports have appeared in the literature, in most instances confirming the beneficial results obtained from the procedure.[8,9]

Prefrontal lobotomy was performed on 20 patients in this series. (Table I.) Of these, 7 had intractable pain from non-malignant

TABLE 1
TOTAL CASES—20

	RESULT		
	Good	*Poor*	*Doubtful*
Non Malignant	4	2	1
Malignant	10	2	1

TABLE 2
NON-MALIGNANT GROUP

	RESULT		
	Good	*Poor*	*Doubtful*
Multiple Sclerosis	1		
Tabes	1		
Sudeks Atrophy			1
Post Trigeminal		1	
Post Trigeminal		1	
Sciatica	1		
Lumbar Pain	1		

From the Department of Surgery (Section of Neurosurgery) St. Louis University School of Medicine.

Presented at the meeting of the Central Neuropsychiatric Association, St. Louis, Missouri, October, 1949.

sources. The remaining 13 patients suffered from intractable pain secondary to carcinoma of various viscera associated with metastasis. (Table 2.) Three of the more interesting cases of intractable pain from non-malignant cause are of sufficient interest to present in some detail.

Case Reports

E. E., a female, mother of a physician, suffered from a demyelinating disease of the central nervous system. She complained of pain in all body segments, in the head, trunk, legs, etc. She was emotionally tense, crying and in general, quite unhappy with her environment. She received a considerable amount of narcotics over a period of years. There were associated suicidal tendencies. A diagnosis of primary lateral sclerosis and psychoneurosis—conversion hysteria type was made by Dr. W. L. Moore. Electrotherapy had given only partial relief. A prefrontal lobotomy had been recommended. This was performed on August 23, 1948. The patient made an uneventful recovery. Following the operation, the patient was very relaxed; she stopped asking for hypodermics and all suicidal tendencies were gone. Since then she has continued to improve. She is, at present, at home, adjusted, happier, completely free from her pain and her morphine addiction.

The second case is that of an intractable pain of tabetic origin. The patient, a male, age 57 (U.S. Marine Hospital No. 27-599), complained of intense cramping pain in the legs over a period of several years. The pain was of such intense character that he required frequent hospitalization. He would not get out of bed because of the intense pain nor would he allow anyone to move him. On September 7, 1947, at the U.S. Marine Hospital a bilateral prefrontal lobotomy was done. Since that time there has been a striking change in the patient. Lieutenant W. H. Sage, the physician in charge, and the nursing personnel have evaluated him as a much more pleasant and affable individual, who now does not complain of pain, is cooperative, much more readily accessible and approachable. In other words, in addition to the relief of pain, there has been an alteration in personality to such a degree that he is much more socially acceptable.

On the other hand, two patients who had had operations performed for post trigeminal pain have been completely unsatisfactory in their result. In one instance, the operation was carried out on an adult male, a member of a religious teaching order, who had had a trigeminal resection 20 years prior. He had a very good result and had hypalgesia of the entire side of his face but complained of paresthesia around the infraorbital area on the left. An infraorbital resection was carried out about a year prior to our seeing him, without benefit to the patient. A bilateral prefrontal lobotomy was carried out on August 23, 1948 and after a confusional period of about a month, this patient was discharged apparently indifferent to his pain. When asked, he stated that he had pain but he no longer kept on dwelling on the situation. For a brief period he was allowed to return to teaching at a grade school level. Since then, he has regressed; has remained confused; complains of pain and is now institutionalized.

The other patient had had a trigeminal operation elsewhere, following which she developed a motor weakness, a peripheral VIIth nerve palsy, and an ulcer of the nares which bled daily. This was evidently due to an injury to the superior petrosal nerve. This patient had made two suicidal attempts, one by slashing of the wrists and another by gas. A bilateral prefrontal lobotomy was carried out on November 23, 1948. She continued to complain of pain post-operatively but seemed, briefly, to be a little bit more subdued and more approachable. However, recently she has been hospitalized at Malcolm Bliss Neuropsychiatric Hospital. Dr. Thomas Thale, the Medical Director, reported that the patient has not had a satisfactory result from the operation. She continues to complain and is alcoholic now. The operation benefited this patient not at all. (Table 2.)

Thirteen patients suffering from intractable pain secondary to carcinoma were subjected to operation. (Table 3.) In all instances, the operation was offered only as a last resort. Narcotic therapy and other

*Medical Director, Malcolm Bliss Neuropsychiatric Hospital.

TABLE 3

CARCINOMA—13

RESULT

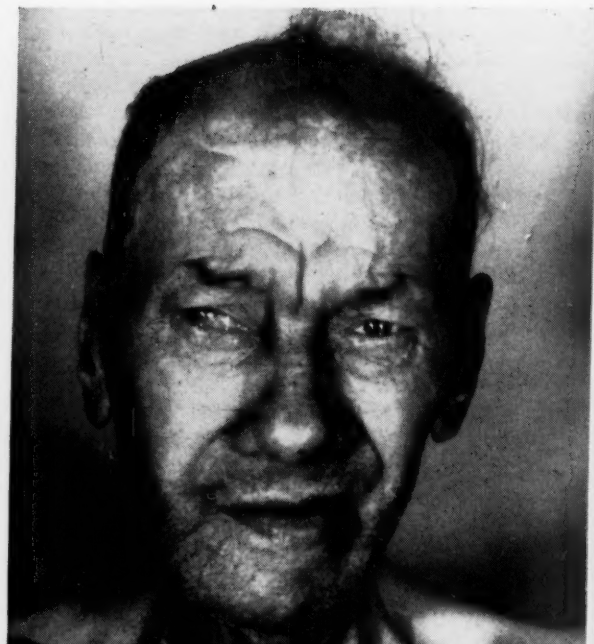
	Total	*Good*	*Poor*	*Doubtful*
Cervix	4	1	2	1
Ovary	1	1		
Breast	2	2		
Stomach	1	1		
Rectum	3	3		
Tongue	1	1		
Prostate	1			

palliative measures had been instituted. Most patients, generally, were in a very poor physical condition and might be classified in that vague clinical group as "pre terminal." In all instances, these patients were suffering from excruciating pain, so that any alteration in relieving them from their wretched agony was deemed worthwhile.

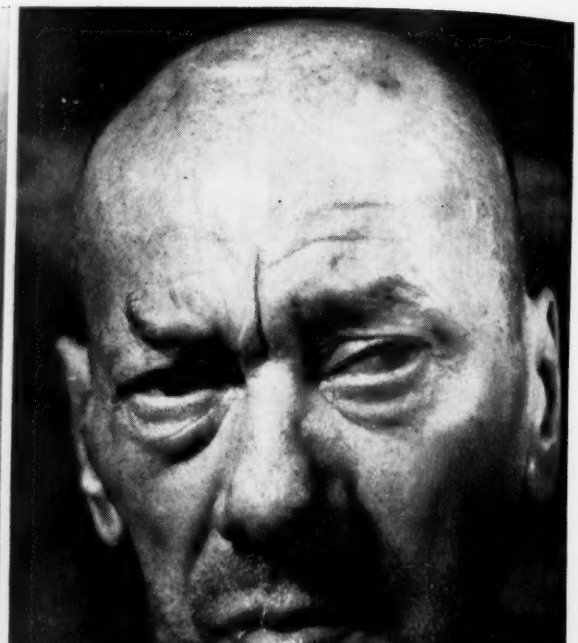
There are several cases of particular interest. One patient (Missouri Baptist Hospital No. 48-9566) had a carcinoma of the cervix associated with severe lymphedema of the vulva and the left lower extremity, so that there was true major elephantiasis. Of interest is a brief summary of the case given by her sister, a graduate nurse.

"So much pain, so nervous and so depressed. She wanted to get rid of everybody on the case. Nobody cared. It took two nurses to get her up on the bedpan—then the burning over the perineum. I never left the room; had to have my meals brought in. We had to move to a much more expensive room with a private bath. She had to have her bath right now or it would burn and hurt. Was so nervous she couldn't wait until I finished my coffee. I couldn't take a bath. If she heard the water running, she would have to go on the bedpan that instant. She had morphine about every two hours, sleeping pills, etc. While this would dull the pain she never really went to sleep. As soon as I moved around in the room she would say, 'Oh! that leg or Oh! that back or it burns, etc. I would take the morphine every five minutes if they would give it to me.' When I did call for a hypo every one or two hours, and the nurse took just a few minutes, she became so upset that it would take sometimes two hours to comfort her or another hypo. It was a living hell for me and for her too. I got to be as much afraid of those pains as she was. She said, 'Don't let anyone handle me but you. I suffer so when they spread my legs on the bedpan, everything burns.' Nobody knows, not even the doctor, except the patient and the one who takes care of the patient for 24 hours. Everything else I have done in life is child's play compared with this. I have always worked away from home besides doing all my own work. Following surgery, she was confused for a brief period and then was completely relaxed. She received not one single hypo; was not crying; was affable; combed her hair; was pleasant and attentive. There has been no pain or hypo since operation. The only thing she has said is that her back is tired. She is sitting almost straight up in bed without discomfort. This is the first time that she has sat up since I have been on the case. Anyone can take care of her now. Before, she wanted none but me, not because it was I but because we had learned together a number of tricks which made her more comfortable. Once in a while she tried to get out of bed mostly when she wanted to use the bedpan. She sleeps peacefully with her mouth closed while before, she was so worn out that when she slept, her mouth was open and her breathing was so heavy that you could hear her two rooms away. When she is awake she is content. It is a miracle in every respect."

Two other carcinoma cases are also of interest. J. R., age 64 (St. Louis City Hospital, No. 67631), was admitted January 28, 1947 with a history of repeated oral hemorrhages following the extraction of teeth eight months previously. Pain and tenderness in the floor of the mouth on the left with dysphagia had been present for three weeks. The physical examination revealed a profuse sialorrhea, an ulcerated mass on the floor of the left side of the mouth and base of the tongue, and a hard mass approximately 5 cms. in diameter in the region of the left jugulo-digastric nodes. A biopsy was reported as squamous carcinoma of the tongue and on February 6, 1947, a left radical neck dissection with radon seed implantation into the oral lesion was carried out. The patient developed a partial loss of skin flap which was allowed to granulate in. Considerable pain developed in this area, in the left jaw, cheek, neck and shoulder for which codeine and demerol were used without relief. During the one month period prior to the prefrontal lobotomy, he received more than 8,000 mgs. of demerol and 35 grains of codeine without adequate relief. (Table 4.) A prefrontal lobotomy was performed on July 10, 1947. On the fifth post-operative day the patient stated that although he was having some pain over the left side of the neck, it had been relieved by the operation. The patient fed himself, was up and about and complained of anorexia but no pain. No sedation was required from the



Patient prior to lobotomy. Note lines of anguish and tension.



Ten days post lobotomy. Note relaxation, increased tissue turgor, weight gain.

time of the operation until his death two months later. (Figure 1.)

TABLE 4

MEDICATION REQUIRED FOR PAIN RELIEF

(Case J. R., St. Louis City Hosp. No. 67631)

Date	*Drug*	*Dosage*	*Doses 24 hrs.*	*Total 24 hrs.*
7/3/47	Demerol	100 mg. Q 3 hrs.	7	700 mg.
7/4/47	"	"	8	800 mg.
7/5/47	"	"	7	700 mg.
7/6/47	"	"	6	600 mg.
7/7/47	"	"	7	700 mg.
7/8/47	"	"	6	600 mg.
7/9/47	"	"	4	400 mg.
7/10/47	Prefrontal Lobotomy			
7/11/47	No medication required for pain relief.			
	Expiration two months later.			

L. W., a female, age 46 (St. Louis City Hospital No. 65179), was admitted on November 23, 1946, with a history of having had a colostomy performed elsewhere for an inoperable carcinoma of the rectum. The predominant complaint was severe pain in the back, shoulders and legs. The pertinent physical findings were cachexia, a 3 cm. mass of carcinomatous tissue protruding from the vagina, and the replacement of the recto-vaginal septum with a large carcinomatous mass. Her pains were almost unbearable and were inadequately controlled with morphine and cobra venom. A total of 122 grains of morphine, 70 grains of luminal and 12 ampules cobra venom were given in the one month prior to the prefrontal lobotomy. A prefrontal lobotomy was performed on March 6, 1947. Post-operatively the patient was responsive, oriented, and complained of no pain other than a mild headache. No post-operative sedation was required. It was noted that her attitude of anxiety and worry had changed to one of indifference and calm. The patient expired about one month later of her metastasis.

There was one operative death. R. B. (Jewish Hospital No. 43-0318), a patient with carcinoma of the prostate was operated on December 2, 1948. He died 48 hours later most probably from an intracranial hemorrhage. Unfortunately no postmortem was obtained.

In two cases of carcinoma of the cervix the post-operative course was characterized by the same intense demanding of relief for severe pain. These were total failures.

In general, the post lobotomy behavior pattern was characterized by a toning down in spontaneous movements, filling out of facial turgor or a striking apathy.[10] Following operation, the patients who had been crying, completely out of control, now smiled at times, would read the newspapers and converse with visitors in a relaxed fashion, although they might be distracted or confused. In some instances, when asked whether they had pain, they would say "no." In another group, when asked if they had pain, they would say "yes" but would easily pass to a completely unrelated topic of conversation. This reaction and indifference sharply contrasted with the pre-operative state in which there had been a constant fixation on pain, gnashing of teeth, shrieking or often becoming maniacal and disturbing the ward. The demand for narcotics spontaneously ceased following the operative procedure. The patient appeared unconcerned, was no longer anxious, yet on stimulation, as with vena puncture, etc., would frequently complain of pain.

Some comment should be made about selection of patients. It is our opinion that the procedure should be offered only as a last resort. Patients suffering from intractable pain of a non-malignant etiology should exhaust all other forms of therapy and lobotomy should be entered into only with consultation and concern. It may be stated that pain per se does not appear to be abolished but it is the emotional response to the unpleasant sensation that is removed.

From the analysis of these cases, it would appear that the primary effect of lobotomy is to alter the patient's appreciation of pain or attention to it and by altering his personality, the anxiety state is so ameliorated that the patient appears somewhat indifferent.[6] It is in this sphere we believe that prefrontal lobotomy has its greatest effect. However, as in the cases reported by Williams,[9] prefrontal lobotomy is not always effective in producing the desired result.

Conclusion

(1) Prefrontal lobotomy is a useful and effective procedure in affording relief to a selected group of cases suffering from intractable pain, particularly those associated with carcinoma.

(2) In all instances when successful in affording relief from pain, associated narcotic addiction is abolished.

(3) Prefrontal lobotomy should be reserved for patients suffering from intractable pain associated with an anxiety state.

(4) In this group of patients this technique is superior to the more exacting procedures such as cordotomy, tractotomy, etc.

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Author's Note: The following Surgical Residents assisted in this study: Drs. Harold Trafton and M. Hara, St. Louis City Hospital; Dr. Bart Passanante, St. Louis County Hospital; Dr. Francis P. Nash, St. John's Hospital; Dr. Joseph Flynn, Barnard Skin & Cancer Hospital; Drs. A. Goldfarb and Sidney Goldring, Jewish Hospital.

Electronarcosis

(As an Adjunct to Psychotherapy)

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Although Leduc[1] first reported inducing the narcotic state with unidirectional current in 1902, it was not until 1934, after Van Harreveld and Kok[2] described the use of alternating current in animals, that much work was done with electronarcosis. Further studies by Van Harreveld and associates,[3] among others, established the clinical feasibility of the procedure. Because insulin therapy is costly in time and effort, Tietz and her associates undertook the use of electronarcosis in the treatment of schizophrenia in the hope of finding a simple, effective substitute. They made their first report in 1945,[4] and since that time have contributed further data on the use of the method in various mental diseases,[5] as well as refinements in technic.[6] Reports on the efficacy and safety of the treatment have varied widely. Bowman and Simon[7] concluded that electronarcosis is "more dangerous than electroshock and less simple to administer" and expressed the "impression" that it is "of no value in treatment of psychoneurotics, is certainly no better than electroshock in treating the manic-depressive psychoses, and is equal to electroshock in the treatment of schizophrenia." They reported that patients often were conscious of treatment and remembered it with horror; that fracture of the spine was frequent (they reduced its frequency considerably in a later series), and that increased excitement, nasal and subconjunctival hemorrhage and petechial bleeding sometimes occurred. Tietz[5b] reported administration of 710 electronarcoses without complications and stated that the treatment was effective not only for paranoid schizophrenia but for some long-standing psychoneuroses and simple depressions. In another report,[5c] she stated that if the treatment is properly given, the patient wakes quietly and is unaware of having been treated. Garmany and Early[8] wrote: "We cannot agree either that the treatment is effective or that it is safe." They reported such complications as severe hemoptysis, clouding of consciousness and collapse similar to that of traumatic shock. Tietz, Olsen and Rosanoff[6] wrote: "Complications need not result from proper electronarcosis treatment. None have appeared in a series of over 5,000 cases." Paterson and Milligan[9] called the treatment simple and relatively safe. Georghan[10] remarked: "There is such a marked difference of opinion in these preliminary reports that one wonders if we are dealing with the same procedure." He reported 600 treatments without clinical evidence of compression fracture of vertebrae and concluded tentatively that although electronarcosis is not specific for schizophrenia, it is valuable and deserves further investigation, particularly when the disease is in an early stage. Tietz[5c] has reported good results even when schizophrenia has existed for many years.

In 1947 I began experimenting with electronarcosis. I varied the technic at different applications, inducing a convulsive seizure at the beginning, sometimes at the end and sometimes at both beginning and end of treatment and sometimes keeping the current below the convulsive level throughout the treatment. I also varied the time of treatment, allowing the current to run for as long as twenty minutes in some instances, although most authors have recommended exposure between five and seven minutes.

After familiarizing myself with a wide range of application and noting variations in response as time and current varied, I was convinced of the relative safety of the method. When orthodox electroshock therapy proved hazardous, as in patients in whom marked cyanosis or prolonged apnea occurred, I was able to continue shock therapy by substituting electronarcosis.

Technic

For routine use I have found Tietz's technic most satisfactory. Essentially this con-

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sists in inducing an initial convulsive seizure, then reducing the current to about 60 milliamperes and raising it again gradually, about 5 or 10 milliamperes per second, until strong flexor rigidity of the arms occurs. Intravenous injection of 3¾ grains sodium pentothal is given rapidly before current is applied through the electrodes and carbogen (5 per cent carbon dioxide in oxygen) is administered through a mask. After the beginning grand mal seizure, the airway is completely inserted and a rubber catheter is used to maintain continuous suction of oral and pharyngeal secretions. Regulated current is continued for about seven minutes in most treatments.

My experience indicates that electronarcosis is useful and often produces improvement when electroshock and insulin therapy have failed. However, it does not replace either conventional electroshock or insulin treatment, but has virtues of its own, which warrant a place for it in the armamentarium of shock treatments. I have observed also a phenomenon not previously reported. I should like to cite two cases to illustrate this.

Report of Cases

Case 1.—Mrs. M. R., aged 32, was admitted for treatment Dec. 18, 1947, with a diagnosis of schizophrenia. She was a devout Catholic, married ten years and lived on a farm with her husband and one child, aged 9. She was a high school graduate and had never been employed. Her husband was nearly illiterate, schizoid and apathetic, but industrious.

The patient was the youngest of five siblings, of whom her three brothers were professional gamblers, and her sister, a nun, had died of cacinoma in October 1946. Her father and mother were living and well. The patient had always been "kind and generous" and solicitous of the feelings of others. She had always cared for the needs of her parents, whom she had visited every day, even after her marriage.

One year before admission, she had begun to feel "nervous" and suffered from frequent headaches. Her brother had taken her to a clinic in another city for study of her condition. She was dismissed with the report that no organic disease was present. Shortly after her return home she had become neglectful of her house and family. At times she was disoriented, suffered from insomnia and had the delusion that her sister was not dead. Two months before her admission she had experienced a marked increase in sexuality and made unusual demands on her husband at all hours of the day. Two days before her admission she had hallucinations, and was disturbed and destructive.

After a course of electroshock and insulin therapy, she seemed improved, pleasant and cooperative. She was discharged on Feb. 6, 1948. Within two weeks she was returned to the sanitarium. She was excited and noisy, talked irrationally and used profane and obscene language. After further trial of electroshock and insulin therapy, she showed no improvement, and arrangements were made for her commitment to a state hospital. Because of her family's reluctance to take this step, it was decided to try electronarcosis. This treatment was begun on April 3, and the patient responded well, becoming more quiet and cooperative.

At the conclusion of one treatment the patient sat up and said: "Please help me to get well quickly." She then asked to speak to me alone. After the nurse left the room she told me that while she had been at the clinic for study a year before she had stayed in a hotel and had had sex relations with one of the resident physicians. She discussed the incident in detail and the disclosure of this disturbing experience led to an understanding of her condition. The phenomenon of spontaneous release of traumatic material immediately after electronarcosis has not been reported previously.

The patient was given further treatment and on May 2 was considered well enough to be discharged. At present she drives a car, does her marketing and carries on the activities of an average housewife.

Case 2.—Mrs. M. K., aged 36, was brought to the sanitarium by her father on Nov. 22, 1948. She had been in a state hospital in Florida from April 1946 to October 1948, under a diagnosis of paranoid schizophrenia. Because her husband showed no concern in the matter, and her father was not satisfied with the reports from the Florida hospital,

which included the statement that she had not "responded satisfactorily to modern methods of treatment," her father brought her to Chicago. In view of the fact that she already had had electroshock and insulin treatments, the consulting psychiatrist suggested that electronarcosis be tried.

At admission to the sanitarium this patient talked with a decided French accent, signed herself "Queen Marie Antoinette" and offered her hand in an affected, queenly manner. She spoke of her first son's royal lineage. The patient was 4 feet, 10 inches tall, an important fact in her developmental history. Her physical examination showed no abnormality.

Her father contributed the information that she had five children, one by her first husband, whom she had married at 17 and divorced, and four by her present husband, whom she had married at 24. As a child she had been "very smart and well behaved." She had appeared on the stage at the age of 2 years, begun elocution lessons at 6 years and piano lessons at 10 and won amateur contests with the ukulele and the violin. She had left high school in her sophomore year. At the time she was taken to the state hospital, she had been restless and had delusions, for example that her blood was being used to save people, that the radio tower was using her as an example and that all the radios should be turned off at the central station because the voltage went through her body. Her father could not account for her French accent, nor could he explain the antagonistic attitude she showed toward her mother.

Electronarcosis was begun, and at the conclusion of one treatment, the patient indicated a desire to talk to me. Because of my experience in case 1, I was prepared to make the most of the opportunity she offered. She told me three significant facts: 1. Her first husband, a truck driver, had been caught raping a girl and had been convicted for the offense. Because of this she had obtained a divorce. 2. She was her parents' fifth child. The first three had been boys, who had died in infancy, and the fourth, also a boy, had received all her mother's love. For this reason she had repressed her feelings. "My heart is like ice," she said. 3. She loved her children, but did not care for her husband, whom she considered a weakling. When asked if she was affectionate, she repeated that she loved her children but stated that she did not care for sex relations. In explanation of her frigidity she said she had fallen on the edge of a chair when she was 4 years old, and the physician who attended her had said it was impossible to predict the outcome of the injury. On inquiry, her mother confirmed the foregoing facts, but asked how I knew them, since they were unknown to others.

These facts provided an insight into the dynamics of the patient's psychosis. It was easy to see why she, and especially her first son, the son of the offending truck driver, had to be royal, in compensation for the shame she had felt over the rape episode. Through psychotherapy it was possible to reintegrate the patient's personality.

Since her recovery the patient has contributed the following facts concerning her history: She had always been shy and self-conscious, and had never liked sex experience or conversation about it. She had married the second time in order to have a husband and not too much sex life, since the man she chose was lethargic and never "annoyed" her. She said she had never masturbated. At her first menstruation she had thought she was bleeding to death. Her idea of childbirth had been that a baby "had to be cut out." She described her father as happy-go-lucky and generous, but expressed strong resentment toward her mother, since the latter had concentrated her attention on her brother, who was diabetic. She said also that her mother had never taken care of her own health and that the patient had had to do all the housework during her mother's illnesses. While caring for her mother she had lost considerable weight; her thyroid gland had become overactive, and she had had to undergo thyroidectomy. She had always resented her brother, who teased her about her size, calling her a midget. She had always been sensitive about her height, since the other members of her family were tall. She had a maternal feeling toward her sister, who was born when the patient was 13. The midwife had placed the baby in her arms, saying, "Now you are

the mother." Since then the patient had played a mother role. She had left high school after a teacher had accused her of copying another student's work, which she claimed was untrue. She stated that she had never lied in her life.

Her present husband had humiliated her. He had spent little time at home, had lied to her about his whereabouts and had forced her to endure the visits of a woman she did not like. She had wanted a new home, and although her husband had promised to build it, he had erected a nursery instead and kept her and the children in a three-room flat. This had been a great disappointment. The patient also had resented her husband's forcing the children to do work "he should have done himself."

She explained her French accent by the fact that she had studied French while in the state hospital, both to make the most of her time and to avoid kichen duty—"peeling potatoes."

Comment

These two cases are illustrative of many others in my experience, and confirm the observation that electronarcosis is entirely different from other shock treatments and adds another weapon to the therapeutic armamentarium. Electronarcosis made it possible to reach the patients while they were beyond contact by any other method, and provided clues which proved valuable in unraveling their difficulties through psychotherapy.

With such terms as psychoanalysis, hypnoanalysis and narcoanalysis as precedents, one could even suggest "electroanalysis" as a name for the phenomenon observed in these cases. Reports of other workers observing this effect should prove valuable in assessing its frequency and importance. Its significance lies in the glimpse it provides into the dynamics of the disease while the patient is still psychotic.

Conclusions

While electronarcosis does not replace electroshock or insulin therapy in the treatment of mental disease, it has its own merits and has succeeded in some cases when other methods have failed. It is a valuable adjunct to psychotherapy because it helps release repressed material which furnishes clues to the basis of the disturbance.

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Psychoanalytically Oriented Institutional Treatment of Children

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The Forest Park Children's Center is an institution for the resident treatment of emotionally disturbed children established and supported by the Junior League of St. Louis. Here a homelike atmosphere is sought to be achieved. Accordingly a large but not austere residence is used, in a pleasant residential district; front and back doors are kept unlocked; the children attend the neighboring public and parochial schools, going to and from school unescorted.

Treatment consists of psychoanalytically oriented group living and individual therapy by the director who is a psychiatric social worker. Psychiatric consultation is rendered by the author.

The capacity of the Center is 10, varying in age from 5 to 17, the average being 9; the ratio of boys to girls treated being 2:1, the average length of stay has been 10 months, the per capita cost is $6.60 per day. Children with the following personality patterns and problems have been treated: anxiety and conversion hysterias, obsessive-compulsive pattern, other neurotic characters, borderline schizophrenia, and pseudo-feeblemindedness. Symptoms included:

Aphonia, anorexia, attempted suicide, bestiality, compulsive masturbation, depression, disobedience, eneuresis, exhibitionism, fetishism, firelighting, homosexuality, hyperactivity, lying, masochistic behavior, nailbiting, night terrors, overeating, psychogenic illness, ritualistic behavior, sadistic behavior, soiling, stealing, temper tantrums, thumsucking, tics, truancy, voyeurism.

Children with organic syndromes or with below average intelligence (I.Q. below 80) are not accepted. Other reasons for rejection of applicants include: attitudes in the parents likely to vitiate treatment effects in the child, delinquent attitudes with insufficient conflict and anxiety to permit of real access to the child, children whose early oral experiences were so extended and damaging that years rather than months of treatment would be needed, children from very primitive rural areas whose culture would fit them poorly with the other children in the Center, and children with well developed psychoses.

They are referred by 10 social agencies, clinics and courts in Greater St. Louis. The agencies supplement whatever amount the family of the child is able to pay so that $60.00 per month is paid to the Center for each child. The social agencies also carry out the case work with the parents and other pertinent relatives of the child.

This is a report of the first 40 months of the Center.

The admission procedures include full social, medical, and psychological studies (including projective testing), supplied by the referring social agency, one or more visits to the Center by the parents and the child, and joint staffing by the referring agency and the Center staff.

The initial joint staff meeting or meetings concern themselves with the following questions and problems: should the child be accepted at the Center, what are reasonable treatment goals for him—improvement sufficient to return home, or for placement in a foster home or does long time institutional care seem probable; the agencies' problems in working with the parents; the child's formal educational program while at the Center, what shall be the initial and long time psychological strategy for him in the group living and in the individual treatment at the Center.

The Group Living

A description of the staff is of the essence in describing the milieu therapy. There are one full-time woman worker and four part-time workers, two men and two women. At least one man and one woman are always on duty. There are also two women who cook and keep house. The house staff is young, averaging 24 years, its members have not been psychoanalyzed, but are

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cheerful, resilient, and intuitive. The part-time staff are graduate students in social work, psychology, group work, education, etc. In the beginning there was considerable turnover of staff but it is more stabilized now. In the last 18 months replacements were due to causes not within the control of the Center: marriage in three instances and further education in two others. Salaries are $120.00 to $160.00 a month with full maintenance. Vacancies now can be and are quickly filled.

The Center is located at 4919 Forest Park Avenue, two blocks from Forest Park. The house has 14 rooms, three bedrooms are used by five staff members, and the children sleep in rooms with 2, 2, 2, and 4 beds respectively. The 110 by 200 foot lot affords considerable outdoor play space suitably equipped and in the rear there is a 40 by 20 foot one-story structure with arts, crafts, and play equipment.

In attempting to develop a home-like atmosphere the staff has been encouraged to considerable spontaneity in the expression of their feelings toward the children, much like parents and older siblings would feel toward and act toward the younger members of a family. Thus expressions of affection and spankings are included in the range of staff members' relations with the children. The house staff are exposed to full knowledge of the psychological conclusions regarding each child which have been formulated by the director, the consulting psychiatrist, and the agency psychiatric social worker. The house staff furnish most of the observational data from which the psychiatric formulation is periodically revised during each child's stay at the Center. The members of the house staff take turns keeping a short daily log to document their impressions and keep the director immediately and constantly informed of the situation as to each of the children.

Treatment centers like this in attempting to veer away from too rigid institutional control often fall into the error of insufficiently supporting the instinct ridden child's weak ego against ungovernable instinct pressures. The increasing misbehavior of such a child finally results in the belated application of administrative discipline which because of the delay and increased severity cause damaging surprises to the child and nourish his suspicions that the soft answer of parents and parent substitutes is but the camouflage behind which wrath stalks him unawares.

Personnel in treatment centers in addition to the conscious wish not to act like jailers are subject to identification with various aspects of the child—his littleness, weakness, badness, capacity for ingratiation, and seductiveness, etc., and to fears of the devastating strength of their own unconscious hostile aggressive drives if even a little expressed in the punishment of a child. Therefore the natural self-discipline by the children of each other is supplemented by house staff counsel, correction, diversion, restraint, and punishment.

The director is a psychiatric social worker with five years previous experience at the Ryther Child Center in Seattle, married, a father, and does not live at the Center. This background information is mentioned because it is believed that in addition to psychiatric knowledge, previous experience in a good psychiatric resident treatment center and normal non-institutional living satisfactions are valuable factors in the choice of a director and in his way of living for this kind of a Center. He is employed by and responsible to a board of 16 Junior League members and five non-League members. He is both the administrator of the Center and the individual therapist of the children. In these often-considered mutually antagonistic tasks he is assisted by three hours of psychiatric consultation time per week. A relatively mature psychiatric social work student does a limited amount of case work and carries one case in individual therapy.

In his individual therapy, the director sees each child two or more times a week, for interviews which average 30 minutes each, plus emergency interviews. Play and verbal techniques are used as the age and state of the child may indicate.

Course

The child makes one or several visits to the Center both as part of our preliminary study of him and as his participation in and acceptance of his coming to the Center to

live and to get help with his problems. His behavior and attitudes are usually exemplary but distant during the first days and sometimes weeks in the Center. He does not really accept as valid and likely to last the staff's friendly, permissive, encouraging attitudes. These he regards as a decoy to lure him into a dependence which will be frustrated (as he may earlier have experienced from other parent substitutes—teachers for example). He avoids misbehavior especially. Then he begins to see that his companions at the Center are involved in closer relations to the staff, act and feel more spontaneously and express their symptoms including anti-social behavior. Tension mounts in him because he has inhibited his usual tension discharging ways of expressing himself. After the first or second week his neurotic misbehavior becomes marked. This "improvement and relapse" of course is not so evident in the more fearful, self-punishing child in whom frank evidences of severe anxiety are evident from the beginning.

The child now can and does extend his previously more guarded efforts to gain instinctive gratifications. He becomes more ingratiating and seductive, or rebellious and defiant, or freer in soiling himself, or angrier and more destructive, braver in his sexual expressions, or in his voracity for food, sweets, or the possessions of other children and staff members. Whereas earlier he had minimized to the therapist the extent of these manifestations, now the strength of the instinctual drives, the anxiety from distorted conscience, and the anxious expectations of external retaliation, whether hot anger or cold withdrawal—all these fearful matters now make the therapist and the therapy an urgent affair for the child. The therapist's early suggestion that child's maladjustment could and needed to be understood and that was why the child was in the Center becomes very meaningful to him. In this liquescent state he is treatable and there is real therapeutic movement. During this period the staff attempts to follow the principle of permitting the child's expressions to extend to the limits of safety for himself and others, the limits of neighborhood and school tolerance, and the staff's own capacity to take it.

Again the course necessarily is different in the child whose hostility is more turned against himself, who feels inferior, depressed and resigned to what he has so far found to be a loveless world. Here much ego building, active bringing of love to him over a prolonged period are needed before he can begin to somewhat take matters into his own hands and strike out more aggressively for himself.

Returning to our more aggressive child some calm may follow his stormy intervals, some partial consolidation of his more mature patterns. Then new upheavals occur perhaps stirred by a home visit or some experience of rejection by a teacher puzzled by the child's swings of feeling and behavior. These disappointments and regressions permit of therapeutic working through of the child's problems to increasing depth and he becomes prepared to attempt an adjustment away from the Center. After his discharge he may return to the Center for individual treatment as needed.

Results

The results of course vary widely and have not been sufficiently time tested at this Center. Our general psychiatric knowledge and the specific experience of other centers forewarns us that we can merely estimate how well the discharged child will withstand the certain strain of increased instinctual tensions in adolescence and the uncertain but surely often enough outrageous slings of fortune in any individual's future.

More immediately, however, of the 23 children who have been at the Center 4 or 17 percent were withdrawn prematurely by their parents. The following data includes all children treated except those withdrawn by their parents within two months of admission and one child whose family had left the state and therefore could not be reached for evaluation.

	At Time of Discharge		*Today*	
	No.	*%*	*No.*	*%*
Returned to own home	10	55	10	55
Placed in foster home	4	22	4	22
Placed in institution for dependent children	3	17	3	17
Placed in corrective institution	1	6	0*	0

*(One child returned to the Center from a foster home.)

Perhaps brief examples can illustrate how the outcome can be considered. One boy previously unable to adjust in an institution for dependent children or in foster homes had a stormy 15 months stay at the Center in which his homosexual tendency became quite overt. This and much other of his aggressive behavior had to be considerably curtailed. He was able to drop his defense of gayety and let himself feel real depression reminiscent of the traumata of the early years of his life, during which time he experienced the disintegration of his mother whose death from alcoholism occurred when he was four. Rather poorly controlled homosexuality and depression were still present when he was placed in a foster home 15 months ago. He has done surprisingly well in this home, in summer camp, and in his school. His ultimate adjustment cannot be entirely mature or comfortable—it may be conforming. He is classified as improved.

A ten-year-old boy, guilt-ridden, hyperactive, masochistic; also exhibited petty stealing, minor delusions, marked nonachievement and psychogenic speech defects. In the Center he progressed from over-conformance to extremes of non-conformance including truancy, homosexual behavior, and verbal and physical aggression toward adults. After 15 months at the Center he was returned to his home which had somewhat stabilized through increased maturity of his elder siblings. His speech has improved, school and social adjustments are adequate, and he is able to accept the imperfections of his family. He is classified as improved.

Another boy came from a home in which the parent's delinquency was more cultural than conflictual. The Center's technique did not succeed in mobilizing this child's anxieties sufficiently to effect a deep change. He learned to conform but developed no real feeling. For 10 months he was well behaved in an institution for dependent children. Withdrawn by an aunt against advice he has been found in one stealing episode in the subsequent 18 months. His adjustment is classified in the group of negligible results.

In the classification of improvement are placed those children whose emotional problems were believed to be well worked through based on the evidence of psychotherapeutic material and behavior at the Center at the time of discharge and the subsequent behavior in home, school, and community settings.

Using such criteria the outcome to date is:

	Number	*Percent*
Improved	14	77.7
Negligible results	4	22.3

Average number of months since discharge is 17.

In general the results were poorest in the inhibited and very anxious children and in those cases in which parental interference could not be effectively handled.

In considering the total number treated in 40 months it should be explained that the Center operated at considerably below capacity in the beginning when many problems of staff development, organization, development of technique and referrals had to be solved. A report on the present operation would show a considerably higher annual rate of children treated since the Center has been operating at or near capacity with a waiting list and a turnover of completed cases of about one per month.

Summary

Fourteen or 78 percent of 18 children treated at a resident psychiatric treatment center for children averaging 12 months' treatment each have shown improvement in their adjustment to date. The techniques used were those typical of a psychoanalytically oriented resident center for children with emphasis on the following features:

1) The establishment of a homelike and therapeutic atmosphere.
2) The carrying out of administration and treatment by one person.
3) The use of unanalyzed, healthy, youthful house staff.
4) The securing of analytic orientation through limited psychiatric consultation.
5) The use of considerable firmness in handling the children.
6) The carrying out of case work treatment of the parents of the children by the referring social agency.

Neurological Clinical Pathological Conference

of the

Cincinnati General Hospital

CHARLES D. ARING, M.D., *Editor*

Case No. 212859

Presentation

A 58-year-old colored laborer entered the hospital on July 11, 1949, where he died on August 1, 1949. His only previous hospital stay had been in the spring of 1946 because of right lower chest pain. Then there had been a cough productive of tenacious, white mucus, but there was no fever, vomiting, or hemoptysis. Previous colds had not required especial care; past history was not remarkable.

Examination in 1946 revealed a blood pressure of 108/70, pulse rate of 86, respirations 32 and temperature 103 degrees F. He was thin but not malnourished. His remaining teeth were carious. He breathed rapidly and had pleuritic pain on respiration. There was limited chest expansion on the right, with decreased resonance and absent breath sounds below the angle of the scapula on the right. A cursory neurological examination was normal. The hemoglobin was 10.2 gm., red blood cells numbered 3.2 million; white blood count was 17,150, with 91% neutrophils, 7% lymphocytes, and 2% monocytes. Urinalyses were not remarkable.

Roentgen examination revealed multiple areas of encapsulated fluid in the right thorax. Thoracentesis yielded 750 cc. of foul, thick fluid packed with pus cells and debris. No organisms of tuberculosis could be demonstrated. Cultures revealed actinomyces nigricans on two occasions and streptococci on a third.

Thoracostomy was performed shortly after the 1946 admission, and penicillin and sulfamerazine were begun. Open thoracotomy was finally done. Tissues removed at operation were found to be granulation only. Pus formation ceased (indicated by diminishing drainage from the tube). The wound began to close. Roentgen studies showed the chest fluid to have disappeared. The patient was discharged and was followed in the clinic. On one visit a broncho-pleuro-cutaneous fistula was detected by the fact that the patient expectorated the saline fluid used in irrigation. Roentgenograms revealed a shifting area of infiltrate in the right upper lobe. The wound ultimately closed, and the patient failed to keep his appointments thereafter. On the last visit weakness of the right arm and atrophy of the deltoid were found.

The patient was next seen on July 11, 1949, some three years after the last clinic visit. His activity during the intervening time could not be learned. Weakness and numbness of the right side had appeared on July 7 concomitant with dizzy spells and falling. There was progression of symptoms until he became unable to walk.

His temperature was 99 degrees F, the blood pressure 108/70; respirations were 20 per minute. Diminished breath sounds were heard on the rigst, with variable rhonchi. Frequent violent coughing spells were observed. Neurological examination revealed weakness and impaired coordination of the right limbs, with poorly defined jerking movements of the head to the right. Decreased pain and touch sensations and absent vibratory appreciation were noted on the right. Deep reflexes were accentuated on the right, where there were extensor plantar responses and absent abdominal skin reflexes.

There were 11.2 gm. hemoglobin, a 3 million red blood count, 7150 white blood count and a normal smear. Urinalyses were essentially normal. Sputum was purulent and bloody with a mixed flora; and no acid fast organisms. Cultures failed to show fungi or tubercle bacilli. PPD tests first and second strengths were negative. Lumbar puncture revealed a pressure of 65 mm. water and clear fluid. No cells were present. The determinations of protein, glucose, and chlorides were 23, 51, and 683 mg.% respectively. The Wassermann and gold curve were negative.

The jerking of the head became more marked and soon spread to involve also the right arm; their frequency was counted at 60 per minute with short remissions noted. On July 12 localized fits were replaced by generalized, clonic seizures, and the level of awareness was reduced alarmingly. Paraldehyde, phenobarbital and dilantin inhibited the seizures. On July 13 he was disoriented but able to follow simple commands. Paralysis of conjugate eye movement to the right and nystagmus on left lateral gaze were noted. Complete right hemiplegia was present. In addition there was weakness of the left leg. There was no asymmetry of the deep reflexes; those in the lowers were hypoactive. An extensor plantar response was elicited on the left, with no reaction on the right. Sensation could not be evaluated. Lumbar puncture at this time showed the pressure to be 70 mm. of water, with no cells, and a protein level of 19 mg.%. Roentgenograms of the chest showed diffuse patchy densities of the right upper lung field. Roentgen studies of the skull were normal; the pineal gland was not visualized.

Therapy was with penicillin and streptomycin. On July 14 there were occasional generalized seizures; he was able to recognize friends between them. His temperature rose rather abruptly to 103.5, and he appeared to be losing ground. However, the fever descended to 100-101, and he became more lucid on July 18. On July 19 careful examination revealed general weakness, with frequent gen-

eralized seizures in which the head and eyes deviated to the right. Consciousness was maintained throughout the seizures. He was rational and cooperative, but slow to respond. Right homonymous hemianopia was apparent and the weakness of lateral gaze persisted. The only voluntary motion possible on the right was in the forearm and fingers. Sensation remained impaired. The speech was thick and weak and there was grimacing. Sudden spontaneous movements occurred, which were non-rhythmic, bilateral and continuous, of the proximal parts of the limbs (especially the uppers) and of the head. These movements were accentuated by such things as questioning the patient or by any effort on his part. They became more prominent subsequently. There was no response to plantar stimulation.

On July 23 thrombophlebitis appeared in the left leg. Anticoagulant therapy was begun. The temperature again rose to between 102 and 104 degrees. The BUN was 40 mg.%. Cheyne-Stokes respiration appeared on July 24. The phlebitis became worse. On the morning of August 1, weak tachypnea, cyanosis, and sweating were noted. Death ensued later that day, shortly after the BUN had reached 180 mg.%.

Differential Diagnosis

Dr. Charles D. Aring: Perhaps our first problem should be to determine what the relationship was between the two illnesses suffered by this 58-year-old man. It is quite obvious that there was infection in his right thorax during both hospital admissions. That the first illness had anything to do with the neurological disorder present at the time of final admission, I am inclined to doubt. The only indication that there might have been some trouble neurologically during the initial illness was found in the final visit of our patient to the Out Patient Department, when he was seen to have some weakness of the right upper extremity. This, it is said, was confined to the right arm, which I take to mean that part of the upper extremity above the elbow and there was some deltoid weakness. We know that he had undergone a major surgical procedure of the right side of the chest, and I believe it likely that the right arm had been abducted prolongedly and that something may have happened to the nerve supply of this extremity because of the position on the operating table. That this might not have been discovered immediately post-operatively is manifest since attention was directed at the pleural cavity. It seems that the patient wasn't too informative in any case and perhaps neglected to mention that his arm may have been weak immediately post-operatively. We know that such peripheral syndromes are not unusual particularly in persons whose metabolic equilibrium has been prejudiced by debilitating disease.

The lack of contact with this patient over a period of three years suggests that he was getting along reasonably well. It isn't likely that a desperately ill colored man of this age in this environment, would have escaped these precincts for such a prolonged period of time. Thus, while I am inclined to believe that the lesion in the chest may have been similar from the etiological standpoint, I don't believe that it metastasized to the central nervous system much before the few days or weeks preceding the second hospital admission.

We may now proceed to the localization of this disease, and then to differential diagnosis. I found it impossible to localize this central nervous system lesion. The most obtrusive sign perhaps was the occurrence of seizures, which began sometime in early July with turning of the head to the right; later the right arm was also involved in them, and finally on July 12, this man was having generalized seizures. So it sounds as though over a period of 24 or perhaps 48 hours he developed this progression of seizures, most likely indicating localization in the left frontal lobe.

You know that there are several places in the cerebral cortex where stimulation will result in turning of the eyes to one side. When the stimulus is of a certain nature and not too strong, the effect need not spread; but if it spreads to adjacent cortical areas, then turning of the head will result—certainly from stimulation of the pre-Rolandic centers in the frontal lobe. While these cortical cells give off fibers which descend through the knee of the internal capsule, I know of no evidence that localized fits such as this man had can be induced by stimulation at levels lower than the cortex.

So I must postulate that this lesion involved the cortex, and I believe particularly the cortex in the left frontal lobe (area 8 of Brodman). Stimulation of occipital centers (area 19) while it results in turning of the eyes, such turning is usually associated with

hallucinations, such as sparkles and flashes of light. This was not complained of by our patient so I am inclined to a forward localization here.

There is a good deal of evidence that there was disease at levels deep to the cortex. You will recall that the protocol detailed right hemiplegia, diminution of sensation in the right limbs and right homonymous hemianopia. This suggests at once that the lesion is in the white matter of the left hemisphere, and particularly in the posterior limb of the internal capsule. There are other signs that implicate certain gray masses at this level or lower. Toward the end you will recall he developed jerking dysrhythmic movements, particularly of the proximal parts of the limbs with grimacing; these, with certain disorders of speech described as dysarthria and weakness sound for all the world like a choreic disorder and therefore implication of lower basal ganglia, particularly the body of Luys.

To make localization even more complicated, we find that weakness was not limited to the right limbs, but that the left leg also was found to be weak on July 13. So that two weeks before his death, signs developed which quite obviously implicate the other side of the central nervous system. Perhaps, if we maintain a certain allegiance to trying to attribute everything to one lesion, the simplest thing to do is to imagine that the lesion of the cerebral hemisphere was large enough to displace central nervous tissue and particularly the brain stem downward and that the opposite peduncle was forced against the rigid tentorium or even the bone of the posterior fossa. Therefore, the right peduncle was impinged upon and dysfunction resulted therefrom, mainly weakness of the left leg. This is theoretically possible because of the structure of the peduncle at the midbrain level, where the laterally lying pyramidal fibers subserve the leg. The lateral most fibers are those subserving sacral and lumbar segments; and one might presume that if the brain stem were to be shifted downward and toward the opposite side, it would be possible for this syndrome to occur.

Is it possible that this man had more than one lesion in the central nervous system? I suppose it is. The easy way out would be to say, here is a disease which produced multiple foci in the central nervous system; there is one in the frontal lobe and another in the posterior capsule on the same side, and perhaps even others in the brain stem. I would prefer, if we could, to keep the primary nervous lesion single; we'll discuss that in a bit more detail later.

One sign disturbs me, and that is nystagmus on looking to the left. When this sign was observed, the patient had paralysis of right lateral gaze. I'm impressed clinically that nystagmus most frequently arises from lesions of the brain stem and not from cerebral lesions, but there is much to suggest that this sign may have been due to certain weakness of gaze, which certainly may arise from hemispheral lesions. One may see tremor of the eyeball on the basis of involvement of other structures besides those in the brain stem; perhaps Dr. Tschiassny would discuss this point later.

Obviously I can't localize this lesion except to say that it was in the left cerebral hemisphere, that perhaps it was a single lesion that somehow extended from the cortex of the frontal lobe downward and posteriorly to involve the white matter and particularly that of the posterior limb of the left internal capsule, and that by displacement of nervous tissue downward, one may have got one of these notches in the brain stem, Kernohan's notch so-called.

Now as to differential diagnosis, our problem is to consider those lesions that metastasize from the lung. I think we can rule out conditions besides tumor and infection. The disease in our patient could be a tumor in the sense of neoplasia; however, he had suffered for such a prolonged period from lung and pleural infection that it would take a good deal of temerity to fly in the face of this and make a diagnosis of neoplasm. However, it's entirely possible that there was a metastasis or metastases from a lung carcinoma.

The possibility of infection is much more likely. Several points about the modes of metastasis from the lung to brain come to mind. We know that the lung is the most frequent source of metastasis to the brain regardless of the nature of the lesion. The

order in which thoracic infections metastasize to brain are: bronchiecstasis, empyema, purulent bronchitis, then gangrene, tuberculosis, abscess, pneumonia, and finally wounds. Certainly from the clinical description, we must presume that this man had an empyema if not a lung abscess. Perhaps this is the place to examine the roentgen plates.

Dr. J. Park Biehl (demonstrating): The roentgen plates of the chest taken on the first admission showed signs of fluid in the right thorax. On April 16 following thoracotomy, the plates showed satisfactory clearing of the fluid and a picture taken two months after thoracotomy showed much the same picture. Up to this point, there was no clear evidence of lung disease, it was thought that disease was confined within the pleural space. A chest plate taken three months after the onset of the acute attack showed consolidation within the lung itself, limited to the lower lateral part of the right upper lobe, and it was not certain whether or not the base of the left lung was involved. This cleared and subsequently a similar area was seen higher up in the sub-apical portion of the right upper lobe. That was the last film taken in 1946. The films taken in 1949 demonstrated a considerable change; there were scars throughout the upper portion of the right lung field. The significance of this scarring was not clear to the roentgenologist at the time, and it was suspected that a number of abscess cavities were present in the upper lobe. Skull plates showed no abnormalities.

Dr. Aring: It seems reasonable to suspect that this man had an empyema coincident with or followed by a lung abscess or abscesses. Why the brain should be so frequently the site of metastasis from the lung is curious. The brain is rarely so affected in septicemia or in carcinomatosis, yet pulmonary tumor or abscess not infrequently reach the brain metastatically. Some experiments that were done decades ago demonstrated that brain of living animals is not a good culture medium. I don't recall who did this work, but it remains quite clearly in my mind, that bacteria injected directly into the brains of animals rather rarely induced cerebral disease beyond the immediate reaction to the injection. In the healthy animal the brain can handle this type of intracerebral innoculation.

Some experiments by Noran, Baker and Larson[3] throw some light on this matter. Impressed with the frequency of cerebral signs in patients with lung lesions, these investigators injected intravenously small amounts of a diluted extract of rabbit lung to find it fatal within seconds to minutes in all the animals they used. This reaction could be prevented with heparin. They put forward the thesis that in certain types of lung disease, particularly with breakdown of lung tissue, thromboplastin was liberated by the disease. This reacts with the prothrombin of the lung to develop thrombin. Intravascular clotting for some curious reason was apt to occur within cerebral vessels particularly, if not exclusively. Why this happens in this fashion, I don't know that anybody knows, but the fact remains that with breakdown of lung tissue, intravascular clotting occurs in the brains of animals. Histopathological studies have revealed analogous lesions within the brains of humans. It seems possible that this may be the reason why the brain's defenses are breached in some cases of infectious lung disease. It also seems possible that such a sequence of events may have occurred in our patient and that some of his neurological signs may have been due to vascular lesions.

If the nature of the lesion is abscess, what then is the offending organism? Streptococcus was found in one culture and actinomyces in two. As usual when I read discussions written by the students, I learn something. This time I learned from several of them that the actinomyces nigricans, reported in the pus taken from the chest of this individual, is not pathogenic for man. Does this mean that there is no possibility of this brain lesion being actinomycotic in origin? Certainly it's evidence against it. Also against it is our old friend, statistic. I've not been aware of ever having seen an actinomycotic lesion of the central nervous system. Certainly statistically, streptococcus or pneumococcus is much more frequent even than the staphalococcus in brain abscess, the other organisms being even rarer invaders. It is an interesting point that not

all brain abscesses that arise in association with pulmonary tuberculosis contain tubercle bacilli, almost as frequently they contain one of the pyogenic bacteria.

The locale of brain abscess metastatic from the lung deserves brief mention. They are as often single as multiple, whereas brain abscesses arising extra-thoracically are more often multiple than single. Metastatic abscesses from the lung are most often located in the centrum semiovale, about six times as frequently as in the temporal lobe or in the cerebellum. So much for the modes of infection of the brain and the bacteriology.

I think a word is warranted about the cerebrospinal fluid findings in this patient. Since these taps were done on the neurological service, we would like to accept them as reliable; however, I have never seen a case of brain abscess in which the cerebrospinal fluid was as completely normal as it was in the two instances that it was tested here. This would be evidence against brain abscess. I don't know how to reconcile these two points; perhaps chemotherapy may have had something to do with it or we may be dealing with unreliable cell counting.

Towards the end, this patient developed peculiar movements, which I mentioned before when I said that they might be due to involvement of the Luys body and adjacent basal ganglia. If they occurred in the last two days when the blood urea nitrogen was rising, they might represent uremic myoclonus. It is not uncommon that patients terminally in uremia have muscle twitching. That consciousness would be maintained and that these movements should be accompanied by grimacing and speech disturbance takes them out of the uremic category as far as I'm concerned. I believe they are much more likely the result of dysfunction of the lower basal ganglia. The reason for death seems to have been pulmonary embolism from the thrombophlebitis which appeared terminally in the left leg.

I believe that this man had a brain abscess, that it was perhaps confined to the left cerebral hemisphere, and I think that the chances of its being pyogenic rather than actinomycotic are good. The possibility that the bilateral signs were the result of multiple vascular lesions sometimes associated with lung disease is entertained.

Let me say a word about the student discussions. Thirteen of them believed the diagnosis was most likely multiple brain abscesses; another eleven felt that a single abscess was localized mostly to the posterior capsule on the left. One thought that the lesion was hemorrhage in the left centrum semiovale; two that it was tumor of the posterior capsule on the left. One believed that the patient had a thrombosis of the arteries at the base and another that he had encephalomyelitis. Ten students were concerned about the actinomyces found in culture and admitted of the possibility of actinomycotic metastases from the lung.

Student: You said that because of the nature of the convulsions, the lesion should be cortical. Could a subcortical lesion by pressure or otherwise irritate the cortex enough to cause such involvement?

Dr. Aring: Perhaps theoretically. It has been shown experimentally of late that one may produce at least electroencephalographic changes by stimulation of deeper structures; however, I've never seen nor have I heard of Jacksonian fits in man arising from lower levels. Seizures such as the so-called decerebrate and posterior fossa fit result in massive movements, but localized attacks such as these, I don't believe I've ever heard of coming from lower structures.

Student: I didn't interpret them as Jacksonian fits; I thought that rather a single fit started out in the right hand and progressed and that the shaking movements progressed over a gradual period of time to involve more and more of the body. I didn't interpret them as Jacksonian fits.

Dr. Aring: How did you interpret them?

Student: As an irritating lesion that involved more and more of the body.

Dr. Aring: If by involved you mean convulsed, you've given a pretty fair description of Jacksonian seizures.

Student: What should disturb us most about the cerebrospinal fluid findings, the lack of cellularity or the lack of increased pressure?

Dr. Aring: I think chiefly the lack of cellular response. If this was an abscess and involved the cortex as I believe, I fail to see

why the leptomeninges didn't react, and particularly since I envisioned a rather acute process, not having been present for years but rather perhaps for a month or a few weeks before he last entered the hospital.

Pathological Discussion

Dr. Murton Shaver: The autopsy was performed 6½ hours post mortem. Many decubitus ulcers were found over the body. The cause of death was determined as pulmonary embolism with multiple massive infarction of the lungs bilaterally. In addition, infected bronchogenic cysts were found throughout the right lung. Some of these were lined by smooth epithelium and some contained purulent material. Renal cysts were also found. Acute and chronic pleurisy were discovered over the right lung, and a terminal bronchopneumonia was present bilaterally. Acute glomerulonephritis was found to be the cause of the uremia.

Superficial examination of the brain revealed little that was remarkable. A soft area was palpable in the left parietal region approximately 3 cm. from the midline. There was some questionable generalized flattening of the gyri, and generally the leptomeninges appeared normal. There was no evidence of herniation of the hippocampal unci or the cerebellar tonsils, and the midline structures were not apparently shifted. Coronal sections through the brain were generally not remarkable, aside from those made through the left anterior parietal region where there was marked swelling of the white matter in the centrum semiovale and an encapsulated abscess 3 cm. in diameter. This extended outward to the superior surface of the cortex in the area of softening previously palpated 3 cm. from the midline. The capsule was firm and fibrous and the contents of the abscess were grayish-yellow and soft.

and an encapsulated abscess 3 cm. in diame-

Coronal sections made through the brain stem and cerebellum revealed petechiae scattered throughout the brain stem beginning rostrally in the midbrain and extending caudally through the medulla.

Microscopic sections of the abscess wall revealed purulent exudate in the central portion of the abscess with a large number of histocytes more peripherally. A thick wall of fibrous tissue with budding blood vessels extending out into the leptomeninges was found to wall off the pus at the cortical margins of the abscess. At the junction of the leptomeninges with the abscess wall there was an intimate intermixture of fibroblasts and astrocytes and the early formation of a meningo-cerebral cicatrix. The tissues surrounding this fibrous wall showed early proliferation of astrocytes with some deposition of glial fibrils as seen in the formation of a glial scar. Numerous swollen astrocytes of the gemistocytic type are found in this area. There were no cells in the leptomeninges away from the lesion which probably accounts for their absence in the cerebrospinal fluid.

Through the brain stem beginning in the subthalamic region and extending downward through the pons and the periaqueductal region into the floor of the 4th ventricle, were numerous small perivascular hemorrhages associated with necrosis of some of the vessel walls which appeared to be recent. Thrombi were found in some of these vessels. Around a few of these areas there were aggregations of lymphocytes. However, most areas were free from inflammatory or reactive phenomena. Nerve cells in these regions showed chromatolysis and severe changes with cell loss in some cases.

The pathological diagnoses with reference to the central nervous system are as follows.

1. Chronic cerebral abscess left parietal. Gram stain demonstrated the presence of cocci in clumps intracellularly in the abscess, and at autopsy staphylococcus aureus hemolyticus was recovered.

2. Recent hemorrhagic encephalopathy of the brain stem.

The cause for this hemorrhagic encephalopathy is indefinite. There are several possibilities; bacterial toxin associated with the presence of chronic infection must be considered, or toxin resulting from profound damage to lung tissue with subsequent necrosis of the vessels. Uremia must be considered but is not usually associated with hemorrhages. It might be suggested that convulsions associated with the presence of already damaged blood vessels might play a part in producing these small hemor-

rhages. Still later in the clinical course, the use of anticoagulant therapy may have had something to do with the occurrence of hemorrhages in the presence of already damaged blood vessels. Hypoxia also may have been present over a period of time in this case, due to the chronic lung disease.

Clinical Diagnosis

Chronic infectious lung disease of unknown etiology.

Multiple brain abscesses.

Thrombophlebitis of left leg.

Dr. Aring's Diagnosis

Abscess of left cerebral hemisphere, pyogenic, metastatic from lung abscess.

Cerebral intra-vascular clotting secondary to pulmonary lesion.

Pulmonary embolism secondary to thrombophlebitis of left leg.

Anatomical Diagnosis

Bronchogenic cysts of the right lung, infected.

Chronic pleurisy right lung. (Thoracotomy.)

Chronic cerebral abscess, left parietal, due to staphylococcus aureus.

Acute glomerulonephritis. (Uremia.)

Massive pulmonary embolism, multiple.

Phlebothrombosis of femoral veins.

Dr. Aring: It seems that the choreiform syndrome and the weakness of the left leg must be explained on the vascular lesions in the brain stem since there is no other explanation apparent from Dr. Shaver's studies.

Dr. Daniel Osher: Does this pathological picture in any way resemble the Wernicke type polioencephalopathy?

Dr. Shaver: There was no evidence of vascular proliferation of the acute type, and the localization isn't quite the same.

Dr. Josiah Brown: Could it have been due to septicemia?

Dr. Shaver: It is not an encephalitis. There is no evidence of infection in the brain stem.

Dr. Neal Aronson: Was there any evidence of pressure on the right peduncle?

Dr. Shaver: No.

Student: How can the hemianopia be attributed to the hemispheral lesion?

Dr. Shaver: It might be attributed to the edema which extended into the region of the thalamus on the left.

Student: Was the abscess large enough to displace the ventricles?

Dr. Shaver: It compressed the left lateral ventricle a bit.

Dr. Joseph P. Evans: Perhaps because the responsible organism here is of low grade virulence, accounts for the lack of cellular reaction and the relatively mild swelling around the abscess itself. It isn't the typical reaction that one sees with abscess secondary to pulmonary lesion.

Dr. Biehl: The patient had improved remarkably, and we thought after his death that it was unfortunate that he developed thrombophlebitis because he appeared to be on his way to recovery.

Dr. Aring: Was the improvement attributed to the penicillin and streptomycin?

Dr. Biehl: We believed they had something to do with it.

Dr. Evans: It makes one wonder whether you could have cured this man with chemotherapy alone.

Dr. Biehl: I was impressed with the collapsed appearance of the abscess when I first saw the brain. It appeared to be healing. I wonder if that might be attributed to chemotherapy?

Dr. Osher: Was there any ascending thrombosis extending from the abdomen?

Dr. Shaver: No.

Dr. Aring: I think the point made by Dr. Evans that these lesions might be curable with chemotherapy is of vital importance. I would be inclined to attribute the normal cerebrospinal fluids to the treatment, if temporal relationships agree.* I recall one patient whom we believe we cured of brain abscess with chemotherapy alone. He was 65 years old and developed acute otitis media and mastoiditis on the left. He rapidly developed signs referable to the left temporal lobe which became worse despite mastoidectomy. The acute infectioous condition was brought under control over a period of a week with penicillin and sulfamerazine. Subsequently he developed vertiginous and vis-

*Examination of the record revealed that penicillin and streptomycin were begun on July 13 and that the lumbar punctures had been performed on July 11 and 13.

ual fits as well as dysphasia, right hemianopia, hemihypesthesia and weakness of the right arm. These signs were controlled with anti-convulsant drugs and penicillin. We treated him valiantly for four months before we were at relative ease about him; now, over five years later he is well. Whether this was the invasive stage of an abscess or some vascular disturbance that developed in association with the infection, we can't be certain until we see the brain. However, I have the strong conviction that we cured that patient of an abscess, and a virulent one at that, since type 1 pneumococcus was recovered from the blood, the ear drainage (meringotomy) and from the mastoid drainage after operation.

*Dr. Kurt Tschiassny:** May I be permitted to make a comment on the nystagmus observed in this case. In my opinion it is to be regarded as a gaze-paretic nystagmus, the vestibular apparatus not being responsible. There exist two principal types of opto-paretic nystagmus. One is caused by external eye muscle paralysis, the other by impairment of an oculogyric center. The former as a rule is a monocular nystagmus, appearing in the involved eye on attempts to look in the direction of the action of the paralyzed muscle. The other is an associated nystagmus manifesting itself particularly when the patient intends to look in the direction of the conjugate paralysis. In my opinion this is the type we are dealing with in this case.

The mechanism responsible for the gaze-paretic nystagmus may be explained as follows. There are two main pairs of oculogyric centers, a cortical one in area 8 and a pontine pair at or close to the medial longitudinal fasciculus. The latter is called the supranuclear center. The medial longitudinal fasciculus controls conjugate eye movements toward the same side only. We have to assume that the two cortical centers are connected with the supranuclear center of both sides, the crossed connections providing a stronger force than the uncrossed. For this reason it is generally stated that conjugate eye movements to either side are under the control of the contralateral cortical center and, of course, the homolateral pontine center. It seems, however, that in the performance of voluntary conjugate eye movements, both cortical centers are involved. This is in accordance with Sherrington's law of reciprocal innervation. It also conforms with the clinical observation that in complete destruction of the cortical center of one side, some voluntary eye movement in the direction of the conjugate paralysis can be obtained, particularly when the stimulus is supported by impulses originating in the visual cortex.

Accordingly, under ordinary circumstances, on the impulse to look to the right, stimuli are discharged from both cortical oculogyric centers. From the left an excitatory stimulus passes over the stronger crossed connection toward the right supranuclear center and an inhibitory stimulus toward the homolateral one. Simultaneously from the right cortical center, an inhibitory stimulus is discharged over the crossed connection toward the left supranuclear center while an excitatory stimulus travels toward the homolateral one.

Let us now assume a disturbance of the left cortical center as existed in the present case. In the unimpaired right cortex the preponderant force toward the left is no longer neutralized by a force of equal strength originating from the left cortex. As a result of this imbalance the eyes move toward the left, the side of the lesion. Furthermore, any impulse to look away from the side of the conjugate deviation (toward the right) cannot be answered by stronger stimuli arriving from the left cortex, since this side is out of action. The response is now determined only by stimuli originating in the right cortex; by which stimuli both inhibition of the stronger stimulus, which is directed toward the left, and excitation of the weaker stimulus toward its own side is activated. However, suppression of the preponderant force toward the left cannot be kept on indefinitely in the absence of the support usually provided by the left cortex which acts toward the right. Therefore, the weak homogyric stimulus toward the right is soon overcome by the preponderance of the stronger force causing a rapid return of the eyes to their primary position, which is

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conjugate deviation to the left. Another cortical impulse again begins to move the eyes away from the left conjugate deviation but the cycle completes itself repetitively in the manner described. Thus an attempt to look toward the side of the conjugate paralysis i.e. to the right, causes nystagmus toward the side of the lesion, i.e. to the left.

The cortical and cortico-bulbar types of conjugate paralysis (Oppenheim, Roth, Bielschowsky) do not interfere with eye movements initiated by vestibular stimulation, in contrast to the rarer supranuclear type in which, of course, all sorts of conjugate eye movements toward the side of the lesion are interfered with, even those initiated by vestibular stimulation. The concept presented here does not entirely conform with explanations presented in textbooks.[1]

Dr. Evans: I have two historical notes. Those of us who are old enough to have antedated the days of chemotherapy will remember the occasional case of brain abscess remaining dormant for long periods of time. The second historical note is about MacEwen's[2] excellent record in the handling of brain abscesses in the late nineteenth century. His results were approached only recently with the introduction of chemotherapeutic agents. I can think of no other explanation for MacEwen's excellent results besides that in those days neurology was not far enough advanced that abscesses were ordinarily recognized and the problems of transportation were such that patients weren't got into the hospital promptly. MacEwen's patients most likely had chronic abscesses; I don't see any other explanation of his excellent results.

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